

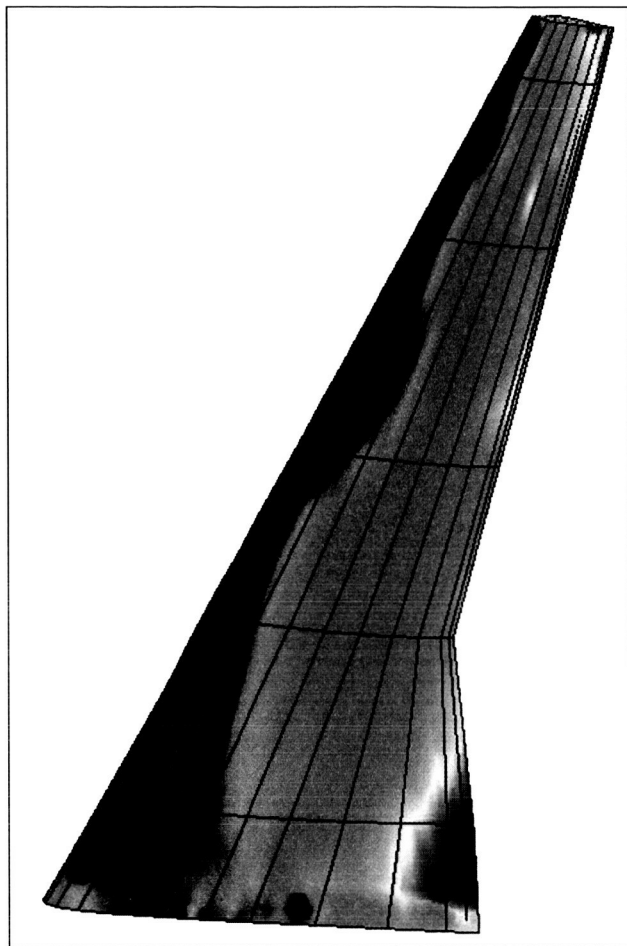


Fig. 1. PSP-derived pressures and grid lines on the suction surface of a transonic wing.

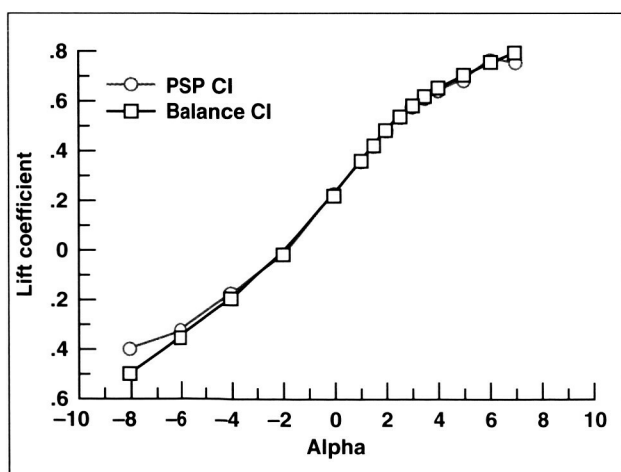


Fig. 2. Lift coefficient determined from balance data and PSP data.

## Wind Tunnel Testing with Fast Time-Response PSP

Edward Schairer, James Bell

Although proven successful for steady pressure measurements, extension of the pressure-sensitive paint (PSP) technique to unsteady flows, especially for rotorcraft, is considered quite difficult. This is partly because of the complex chemistry of a pressure-sensitive paint which has both fast time-response (greater than 1 kilohertz (kHz) as opposed to a typical PSP time response of 1 hertz (Hz)) and a self-referencing capability (often provided by adding a second pressure-insensitive luminescent dye to produce a biluminophore paint). Also, there is the problem of developing a camera coupled to a flash illumination system that is fast enough to stop the motion of the rotor model. Unsteady PSP would allow full pressure measurements on helicopter rotors, which would be of great benefit because rotors are extremely difficult to instrument with conventional pressure sensors.

The objective is to set up an oscillating-wing wind tunnel facility for PSP measurements using flash illumination and to use it to test candidate fast biluminophore paints. The oscillating-wing rig is simpler and more convenient than a rotor model, but it contains most of the model's essential elements: a moving wing and the requirement for measurements over a large surface area.

Two candidate fast biluminophore paints were tested. One was provided by researchers from TsAGI. The second paint was developed under NASA contract by ISSI, Inc. Only the results from the ISSI paint are discussed here. Figure 1 shows a PSP image of the wing upper surface at an 8 degree (deg) pitch angle, showing the suction peak produced by the NACA 0012 airfoil. Figure 2 shows the pressure level along a chordwise line at midspan, again at an 8 deg pitch angle, for the static case as well as for two different oscillation rates. The suction values reported by the PSP decrease significantly in the dynamic cases. This is in conflict with theory, which predicts only a slight change in pressure at the 2-Hz and 5-Hz oscillation rates. These data suggest that the PSP's time response is not sufficient to capture the fluctuating pressures over the airfoil.

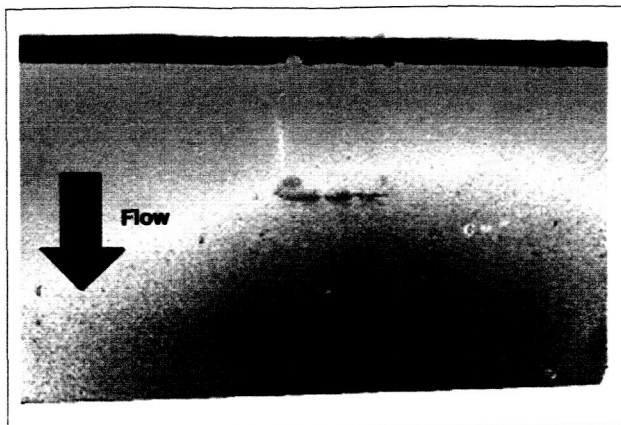


Fig. 1. PSP data on upper surface at 8 deg pitch angle (steady).

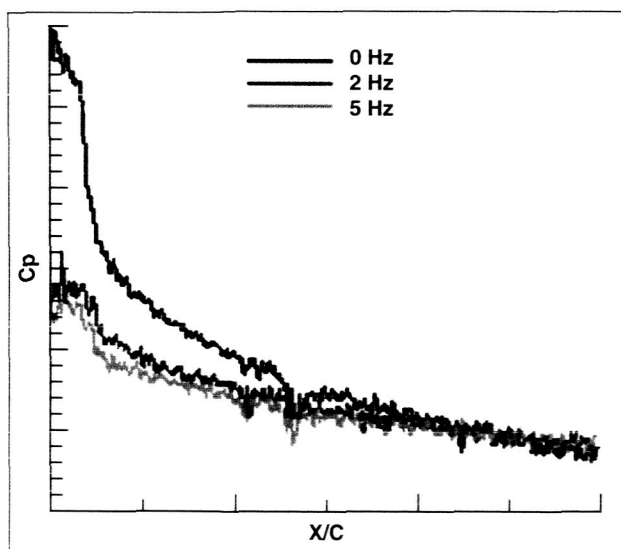


Fig. 2. Comparison of PSP-derived pressure distributions: steady (0 Hz) versus unsteady (2, 5 Hz).

Reformulated versions of the ISSI paint are currently being prepared. A new oscillating airfoil is being fabricated which contains unsteady pressure transducers for direct comparison with the PSP data. New flash units have been obtained which will provide higher brightness with a much shorter flash duration. A second round of testing is to be conducted.

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## Distributed Remote Management of Aerospace Data

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The DARWIN system provides web-based remote access to the integrated knowledge generated from advanced wind-tunnel instrumentation suites and by sophisticated numerical simulation codes. Every year at Ames Research Center, these independent sources generate large volumes of high-quality data on flight vehicles. However, these data are only valuable to the design process if they can be readily accessed, analyzed, and applied by aerospace engineers. The DARWIN system has been developed in conjunction with new computational and experimental test technologies to enhance design-cycle productivity by providing design engineers with faster and better access to these valuable data.

DARWIN allows engineers to securely access and analyze these aerospace data from remote locations. Once engineers have been provided with a DARWIN account, they can use a web browser to visit the DARWIN secure web site and log in. The DARWIN web pages present data from only those tests for which users have been granted access (see figure 1). After logging in users can browse through the tests or query the database for specific information. Data from wind tunnel tests in progress can be viewed on a "live" screen that updates its displays in near real time to reflect the most recent results. Both live and archival data are displayed in user-configurable tables and plots. Once the user has retrieved a set of data and adjusted the tables and plots as desired, the work can be saved as a DARWIN data set. All the user's data sets are stored in a hierarchical "folder tree," which operates similarly to a Macintosh or Windows desktop. The user can add or delete DARWIN data sets, post files (such as text documents or spreadsheets or images), make links to other web sites, and create folders to organize them all. Unlike a PC, however, the folder tree is available to the user via a web browser from whatever machine and location the user chooses.

DARWIN has been deployed at Ames since 1997 as a tool for remotely accessing wind tunnel data. It has been popular with engineers for its live monitoring capabilities and its cross-test comparison features.